Two tropical forests and their birds[1]

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Avifaunal studies were made in two moist dipterocarp tropical rain forests; Gombak Valley, Selangor, Malaysia (3°18′N × 101°43′E), and Khao Yai National Park, Thailand (14°20′N × 101°30′E), for periods of 90 and 32 days 1958-60 and 1970 respectively. 261 species were recorded, 59 in common, 115 additional in the Gombak Valley and 87 at the National Park. Population density in Khao Yai appeared to be three times that of Gombak. Niche occupancy in the two forests is compared. Feeding flocks of insectivores were formed at both latitudes and their compositions are compared. It is suggested that these flocks lack the complex organization described for similar groups of neotropical species.

Karr (1971) recently compared tropical environments of Panama with forest environments in Illinois. McClure (1965) compared the residencies of birds contemporary to environments in Japan and in Malaysia. These are meaningful studies, but somewhat like comparing day and night; the differences are greater and more numerous than the similarities. The present study is a comparison of the avifauna of two tropical forests separated by only 11 degrees but in different climates, tropical rain and monsoon; the Gombak forest at Kuala Lumpur, Malaysia, and the forest of Khao Yai National Park, Thailand.

Description of areas

The Gombak watershed drained by the Gombak river lies at the eastern edge of the state of Selangor, Malaysia, at 3°18′N, 101°43′E and has an altitude of from 600 to 2000 feet. Although thinned of many of the large merchantable trees by lumbering it still presents a closed canopy with a depth of one hundred to two hundred feet. The forest is dominated by Dipterocarpaceae of many genera and species. Trees with a DBH of over 4 inches may be as numerous as two hundred species per acre. Large trees with buttressed boles may include only four or five trees per species per acre. The forest is diverse with a lack of uniformity in species distribution from acre to acre. Fruiting is individualistic by trees (McClure 1966) and so abundant that the bird population moves about the forest following available and preferred foods.

[1] Received May 1972.
[2] These studies supported by the Walter Reed Army Institute of Research, Washington, D.C. 20012, the U.S. Army Medical Research Unit, Kuala Lumpur, Malaysia and the U.S. Army Medical Component, South East Asia Treaty Organization, Bangkok.

Wyatt-Smith (1952) classifies this formation as Lowland Dipterocarp forest which extends up to 1000 feet and Hill Dipterocarp forest 1000 to 2500 feet. These two belong to the world formation commonly referred to as tropical lowland evergreen rain forest. The study area at the Gombak entered both levels of forest. Dipterocarpaceae included 50% of the emergent trees of the canopy, from 100 to 150 feet tall. The 70 to 100 feet canopy included not only young dipterocarps but genera of at least ten other families.

This study refers mainly to the valley between 600 and 1000 feet. A logging road extended for two and a half (2½) miles into the forest following contours above the stream. Once each week observations were made along this road from 0700 to 1200 spending two and a half hours going into and similar time coming out of the forest. These tallies covered 90 days and 450 hours over a two-year period. Birds were recorded and counted by both sight and call. This required a training period so that call counts became more accurate as the study progressed.

The Khao Yai study area was in the National Park at 14°20'N, 101° 30'E with an altitude of between 1500 and 2000 feet. This forest was also a dipterocarp rain forest but at the northern edge of the biome and was much less diverse than that further south. It would fall in the second category of Wyatt-Smith, but still be considered as a tropical evergreen lowland forest. The Dipterocarpaceae are the dominant canopy trees but with fewer species than in the Gombak (Smitinand 1968). Where the canopy was closed the forest presented the same open condition at ground level as further south, but with fewer of the shrub-like palms such as bertam palm (*Eugeissona* sp.). The study area had been cut over once and had more forest edge and less closed canopy than the Gombak forest.

The observation route was along a narrow macadam road through the forest, more open and with less overhead canopy than the trail at Gombak. Studies were made here three days each month for a year, totalling 32 days and 128 hours of observations. Each observation began at dawn and lasted until 0900 requiring about three hours to traverse a mile and return. Birds were tallied by sight and by call. As with the Gombak area figs and fruit trees were very important to the distribution and movements of the birds. The forest offered diverse habitats with an abundance of food. The fruiting patterns of the trees has not yet been reported but seemed to be as individualistic as that in the Gombak valley.

In the Gombak valley the rainfall was distributed throughout the year averaging about 50 mm per week with heavier rains in November and December of 100 mm per week. The dry season of January-February brought the rainfall down to 25 mm per week. Temperature averaged 21°C for the year.

In Khao Yai the annual rainfall was 4000 mm, peak rains occurring during the South-West Monsoon from July into October. During other months rainfall was occasional, sometimes lacking for a whole month. Lack of cloud covering during April-May brought the temperature up to 30°C or above, while in December-January it was as low as 18°C.

Birds tallied in the two areas

There were 174 species recorded along Gombak route totalling 14,631 individuals, and 146 species in the Khao Yai study area totalling 12,596 birds. Some of the bionomics of these data were as follows :

1. *The population ratios :*

The number of species represented by :

	Gombak	*Khao Yai*
Only 1 individual ..	15 (8·6%)	13 (8·9%)
2-10 individuals ..	49 (28·3%)	50 (34·4%)
11-100 individuals ..	73 (42·1%)	48 (33·1%)
101-1000 individuals ..	36 (20·8%)	34 (23·4%)

Apparently there were more species at Gombak in slightly larger flocks than those at Khao Yai.

2. Six hundred miles separated the two forests but there were only 58 species, 20·6% of the total involved in the two areas, that were common to both. These made up 33·6% of the species at Gombak and 40·0% of those at Khao Yai. There were 115 species limited to Gombak as compared with 87 limited to Khao Yai. Either the diversity of niches was greater at Gombak, the birds fitted them more closely than in Khao Yai, or many niches at Khao Yai were vacant.

3. *Population density :* At Gombak there were 450 hours of field observations over a period of three years and at Khao Yai 128 hours over one year. The number of birds tallied per hour was 31·6 and 98·2 respectively. By this method the population appears to have been more than three times as dense at Khao Yai than at Gombak. This may have been an actual difference or it may have resulted from a higher visibility in Khao Yai where the canopy was more open than that along the Gombak route. The number of birds tallied per mile of route through the forest was 66 in Gombak and 321 in Khao Yai, five times as great. To carry this comparison one step further, the average number of birds recorded per day in the field was 164 at Gombak and 321 at Khao Yai. This brings the density down to about double that of the Gombak, but is not valid since the Gombak route is 2½ times that of Khao Yai.

There were 1·2 times as many species recorded in the Gombak valley than at Khao Yai suggesting a more heavily saturated environ-

ment, but when the number of birds per species per observation is considered the figures indicate 0·93 birds at Gombak and 2·7 at Khao Yai, again nearly three times as dense a population at Khao Yai.

Over 500 birds of 70 species were weighed with an average weight of 53 grams. Since the same average figures of birds tallied must be used, a calculation of avian bio-mass in the two areas is fruitless ; 8·6 and 20·8 kilograms per observation ; or 3·4 kg and 17·0 kg per mile.

It is estimated that birds can be seen up to about 100 feet in the forest on either side of the trail. Since an acre is a little more than 209 feet on a side, then for each 200 feet (65 m) traversed one acre has been covered. A total of approximately 25 acres is covered for each mile tallied. By this method the counts determined 2·6 and 13·0 birds per acre respectively. The ratio would not change if reduced to hectares. When reducing the averages to the number of birds per species per observation the figures are 1·76 for Gombak and 6·3 for Khao Yai, still a ratio of 3 : 6. By the data and means at hand the population density at Khao Yai appeared to be between three and five times as great as that at Gombak. See Table 1.

4. *Seasonality :* Peak volumes of precipitation were experienced at the Gombak during November and December followed by two months of reduced rain. Peak population density fell in January during this brief dry spell. At Khao Yai there were two definite seasons, wet from May into October and dry from October into April. Peak population density fell in December when the environment was dry. The peaks in both areas were during the period when migrants from the north were present, 15 species in the Gombak and 25 at Khao Yai. At neither locale were these migrants abundant enough to cause this population peak.

Niche occupation

Udvardy (1969) summarizes the niche concept as follows : ' By " niche "—which we understand in a figurative rather than a concrete or spatial sense, we mean the role of a particular animal or plant in the community which it fills by virtue of its tolerances and requirements (Hutchinson 1957) and its special combination of structural, functional, and population biological adaptations. Each animal species has its own niche, which is not exactly duplicated by any other related or unrelated form. By and large, however, functional counterparts in related ecosystems are said to fill the same niche ; where such a counterpart is missing, the niche is considered to be empty.'

The niche occupancy in the two forests was different both as to species and their abundance. In Table 2 those species tallied in numbers of approximately one hundred individuals or greater are compared by forest and month. These are arranged as couplets and where related

TABLE 1

A COMPARISON OF POPULATIONS AT MILE 13 GOMBAK, SELANGOR, MALAYSIA, 2·5 LINEAR MILES, AUG. 1958—NOV. 1960, AND THE ELEPHANT WALK ROUTE, ONE LINEAR MILE, AT KHAO YAI NATIONAL PARK, THAILAND, JAN.-DEC. 1970

		MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Number of days of observation	G	9	7	7	8	7	6	6	8	8	8	10	6	90	
	K	3	2	3	3	3	3	3	3	3	2	2	2	32	
Number of bird species recorded by sight or sound	G	122	106	107	96	91	92	82	84	82	88	88	78	173	93
	K	56	50	58	53	52	48	50	44	52	40	50	54	145	51
Total birds tallied	G	2169	1418	1503	1287	1086	979	955	1159	969	1016	1065	1204	14810	
	K	1071	573	1191	1051	817	826	870	1180	776	213	763	938	10269	
Average daily tally	G	241	202	215	161	155	163	159	145	121	127	107	201		164
	K	357	287	397	350	272	275	290	393	259	106	382	489		321
Population density based on peak month	G	100	84	89	67	64	68	66	60	50	53	44	83		68
	K	76	61	85	75	58	58	62	84	55	23	81	100		68
Population density based on average tally	G	147	123	131	98	94	100	97	88	74	77	65	122		100
	K	111	89	124	109	85	86	90	122	81	33	119	146		100
Population density per linear mile	G	96	81	86	64	62	65	64	58	48	50	42	80		66
	K	357	287	397	350	272	275	290	393	259	106	382	469		321
Average number birds per species per mile	G	7	5	6	5	5	4	5	6	5	5	5	6		5
	K	19	11	20	20	16	17	17	27	15	5	15	17		17
Average number birds per species per observation	G	1·9	1·9	2·0	1·6	1·7	1·7	1·9	1·7	1·5	1·4	1·2	2·5		1·8
	K	6·5	5·7	6·8	6·6	5·2	5·7	5·8	8·9	5·0	2·6	7·6	8·6		6·3

TABLE 2-(1)

A COMPARISON OF THE COMMON BIRDS OF THE ELEPHANT WALK AT KHAO YAI NATIONAL PARK, THAILAND, AND MILE 13 OF THE GOMBAK VALLEY, SELANGOR, MALAYSIA

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Number of observations	G	9	7	7	8	7	6	6	8	8	8	10	6	90	
	K	3	2	3	3	3	3	3	3	3	2	2	2	32	
Spilornis cheela	G	1·0	1·2	1·8	1·2	1·2	1·2	1·7	1·0	1·8	1·5	1·9	2·1	95	1·3
,, ,,	K	1·0	1·0	1·0	1·6	1·3	1·0	·3	·3	0	0	0	5·5	33	1·0
Argus argusianus	G	2·0	3·0	2·2	2·6	2·9	6·5	5·6	3·7	1·7	1·5	2·0	1·0	196	3·2
Arborophila charltoni	K	1·6	5·0	5·0	5·0	5·0	5·0	5·0	3·3	5·0	2·5	5·0	3·5	137	4·3
Ducula badia	G						2·5	7·0	5·0	1·7	1·0			49	4·0
,, ,,	K	8·0	7·0	14·0	5·3	8·3	12·0	16·0	7·0	5·0	7·0	14·5	13·0	303	9·5
Macropygia ruficeps	G	1·0	3·0	2·0	1·0	5·5	4·0	3·0	4·5	2·0	0	1·0	2·0	96	4·4
Macropygia unchall	K	7·0	4·0	3·3	2·3	11·0	13·0	11·0	10·0	3·0	1·5	8·5	7·0	220	6·9
Treron curvirostra	G	1·5	6·0	2·0			1·5				5·0			28	2·8
,, ,,	K	61·3	·5	3·3	5·0	6·3	5·3	1·3	56·0	4·3	2·0	6·5	41·0	529	16·5

The species are arranged by couplet comparing the two areas : K = Khao Yai, G = Gombak. Blank lines indicate no equivalent in that niche. Some niches are filled by several species at one latitude and one species at the other. Comparisons are made here among species counted from approximately 100 individuals or above, for either of the areas. Figures are the average number tallied per one day's observations.

TABLE 2-(2)

Species	Place	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total	Ave.
Loriculus galgula	G	2·5			15·0	3·0			6·0		2·0			40	5·0
Loriculus vernalis	K	·7	1·0	1·6	6·6	·3	11·3	·7	8·0	1·7	1·2	1·3		113	3·3
?	G														
Glaucidium brodiei	K	1·6	5·0	3·6	3·3	5·6	2·0	4·0	1·3	5·6	·5	6·0	3·3	112	3·5
Apus pacificus	G	21·4		104·0										254	31·7
No equivalent	K														
Chaetura gigantea	G	8·0	2·0	3·3		4·0	6·5	3·0	3·6		10·6	3·6	4·5	103	5·1
,, ,,	K								3·0	3·0	·5			19	2·3
Chaetura leucopygialis	G	11·0	11·1	18·0	13·0	13·4	15·3	21·1	12·2	16·0	8·3	6·6	19·0	1125	13·5
Hemiprocne comata	G	9·0	10·0	8·7	9·5	6·7	10·8	7·8	9·6	7·1	5·0	6·0	7·5	711	8·1
Collocalia esculenta	G	16·0	9·3	4·5	4·5	3·8	6·5	12·4	9·5	7·0	9·7	5·0	20·8	621	9·4
Hemiprocne longipennis	G	6·3	4·1	5·5	3·2	3·4	5·8	5·0	4·4	5·2	4·2	6·3	9·7	368	5·4
No equivalent	K														
Cypsiurus parvus	G		1·0	1·0								8·0		10	3·3
,, ,,	K	1·0	27·0	26·0	20·0	10·7	10·0	15·3	3·3	13·0	2·0	15·5	28·5	443	13·8
*Eurostopodus temmincki**	G	1·9	1·7	1·8	1·2	1·4	1·6	1·2	1·5	1·6	1·0	1·6	1·8	123	1·6
Eurostopodus macrotis	K		2·5	·7			·7	·3	1·3	·3	2·0	·5	·5	32	1·0

* Recorded about 1000 ft. higher on the mountain. Occurs here but has gone to roost before observations started.

TABLE 2-(3)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Merops viridis	G	4·5	6·2	5·0				6·5	2·7	1·0	1·5	5·4	3·5	171	4·6
No equivalent	K														
Anthracoceros malayanus	S*	3·2	2·6	2·5	1·8	3·0			2·5	1·8	2·0	1·8	2·5	145	2·5
Anthracoceros albirostris	K	10·0	4·0	2·0	3·7	2·0	4·0	11·0	6·0	4·0		14·0	10·5	183	5·7
Buceros rhinoceros	G	3·0	2·0	2·7	2·6	2·1	2·9	1·3	4·4	2·1	2·6	2·5	2·7	161	2·6
Buceros bicornis	K	13·0	1·5	8·7	19·0	7·0	6·0	7·3	4·7	6·6	·5	10·0	18·0	276	8·6
Anorrhinus galeritus	G	3·8	4·0	2·2	4·0	3·8	3·0		3·5	3·2	4·0	1·0	5·7	176	3·4
Rhyticeros undulatus	K	3·0	1·0	5·3	2·6	·7		2·0	5·6	2·6	1·0	9·0	6·0	98	3·0
Rhinoplax vigil	G	1·5	2·0	1·9	2·6	1·0	2·8	2·2	2·4	1·1	2·0	1·5	2·2	129	1·9
No equivalent	K														
Megalaima chrysopogon	G	2·3	2·0	1·9	3·4	2·5	1·5	2·5	1·5	1·7	1·0		1.5	103	2·1
Megalaima incognita	K	15·0	15·5	8·3	10·0	7·0	5·7	2·0	3·3		2·0	15·0	16·5	250	7·8
Hirundo tahitica	G	7·4	3·2	2·1	1·7	2·0	2·4	2·0	3·0	11·0	6·2	6·7	8·2	281	4·8
Hirundo daurica	K											12·0	12·0	47	12·0

* = Subang, a nearby secondary forest lower than Mile 13. Listed here for comparison. Not common at Gombak.

TABLE 2-(4)

Species	Place	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total	Ave.
Hirundo rustica	G	15·2	22·3	9·6	10·0				2·7	12·2	7·0	9·0	17·0	672	12·7
,, ,,	K		1·5	1·3	2·7			2·7	6·0				3·0	47	2·9
Hemipus hirundinaceus	G	1·6	1·0	1·8	2·0			2·0	2·0	2·0	1·5	2·0		34	1·7
Hemipus picatus	G	2·6		3·3	1·2	3·0	1·3		2·7	1·0	2·5	2·0	1·0	53	2·1
,, ,,	K	1·7	1·0	4·6	8·0	5·7	2·7	4·0	8·0	2·0	7·0	4·0	6·5	145	4·5
Pericrocotus igneus	G	12·5	8·5	7·5	19·3	18·0	10·0	4·0	5·7	5·8	9·7	9·7	9·0	535	9·9
Pericrocotus flammeus	G	9·0	7·0	10·0	8·4	10·0	7·0	1·0	3·0	3·0	3·0	5·0	13·0	187	6·6
,, ,,	K	5·0	5·5	22·0	14·0	10·7	13·3	4·6	6·7	5·3	4·0	7·0	6·5	299	9·3
Dicrurus annectans	G	1·6	2·5		1·0					2·5	2·2	1·0	1·0	35	1·7
Dicrurus hottentottus	K	16·7	7·0	5·0	1·6	4·3	2·7	2·0	6·3	·7	2·5	14·0	61·5	287	10·3
Dicrurus paradiseus	G	6·8	5·4	5·4	8·2	6·6	5·7	5·3	3·0	3·5	4·6	4·3	6·3	472	5·4
,, ,,	K	1·3	·5	6·3	3·3	3·7	6·0	2·3	3·7	8·0	1·0	2·5	4·5	121	3·6
Oriolus xanthonotus	G	4·1	5·2	2·8	2·1	2·7	2·2	1·6	2·4	2·0	2·3	2·7	3·8	150	2·6
Oriolus chinensis	K	·3	2·0	1·0							·5	1·0	·5	12	·9
Alcippe poioicephala	G	18·1	11·2	17·2	13·0	7.1	12·0	7·0	9·0	2·5	10·5	8·5	6·0	635	10·1
No equivalent	K														
No equivalent	G														
Garrulax leucolophus	K		2·5		2·0	·3	1·3	3·7		7·7	4·0		6·0	105	3·4
Macronus gularis	G	3·5	3·0	5·0	2·8	3·5	4·2	3·6	6·0	5·5	2·0	2·8	3.5	191	3·9
,, ,,	K	12·0	16·0	18·0	14·0	10·3	11·0	6·0	7·3	10·3	2·5	20·0	11·0	364	11·5

TABLE 2-(5)

Species	Place	MONTH												Total	Ave.
		J	F	M	A	M	J	J	A	S	O	N	D		
Malacopteron cinereum	G	6·0	3·8	2·7	3·0	2·0	2·5	9·5	7·2	1·0	8·0	3·5		115	4·8
Trichastoma abbotti	K	4·7	10·0	6·0	5·6	5·6	5·6	10·0	3·3	3·7	2·0	3·0	1·5	170	5·0
Yuhina zantholeuca	G	4·7		2·0	5·0		2·0			28·0	10·0	1·0		60	6·6
,, ,,	K	1·3		2·0	8·3	6·3	9·3	6·7	2·7	1·3		1·5		117	4·4
Hypsipetes viridescens	G	2·3	3·8	4·8	2·0	6·3	1·7	1·0	4·0		3·5	2·3	4·5	116	3·5
Criniger phaeocephalus	G	4·0	2·5	2·0	1·7	2·0	1·3		1·0	2·7	9·0	1·0	1·0	52	2·4
Criniger bres	G	3·0	1·3	2·0	3·0	3·0	2·1	1·5	7·0			3·0	3·7	57	2·7
Criniger pallidus	K	3·7	20·5	24·0	29·0	13·0	19·0	21·0	20·3	10·0	8·5	16·5	15·5	545	16·7
Pycnonotus brunneus	G	4·5	5·8	3·0	2·0	3·0	3·0	2·0	3·0	7·3	3·5	2·0	3·2	164	3·6
Pycnonotus simplex	G	2·0	3·3	2·7	2·0	4·7	1·0		2·0			1·5	2·0	54	2·6
Hypsipetes propinquus	K	·7	7·0	14·0	15·0	26·7	15·7	12·0	5·7	12·3	6·5	10·0	10·5	373	11·3
Pycnonotus atriceps	G	1·5	1·0	6·0	4·0	7·1	4·0	11·4	12·3	4·7	2·0	1·0		205	5·7
,, ,,	K	·7	1·5	1·7					4·0					22	2·0
Pycnonotus cyaniventris	G	1·5	5·0	2·0	4·5	1·8	2·0	3·3	4·4	3·0		4·5	1·0	118	3·5
No equivalent	K														
Pycnonotus zeylanicus	G	1·8	2·6	2·0	2·2	2·1	1·3	1·5	1·6	1·8	2·0			96	2·0
No equivalent	K														

TABLE 2-(6)

Species	Place	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total	Ave.
Pycnonotus finlaysoni	G	2·7	2·5	2·7	2·8	4·4	3·3	4·0	1·6	2·3	1·0	4·5	1·8	173	2·8
,, ,,	K	7·0	6·5	8·0	5·3	1·3	6·7	11·0	4·3	9·3	2·0	4·5	8·5	201	6·2
Pycnonotus melanicterus	G	2·0	1·7	2·2	2·0	4·0	1·0	1·0	1·5					34	2·0
,, ,,	K	5·0	5·7	30·0	28·3	17·0	14·7	22·7	14·3	16·0	7·0	7·0	8·5	515	14·7
Chloropsis cochinchinensis	G	16·3	11·7	9·6	7·1	6·0	5·0	9·4	6·2	4·0	9·3	11·0	13·5	720	9·3
,, ,,	K	4·0		·7	3·3	11·0	8·3	6·3	4·7	9·3	2·5	3·5	2·0	159	5·0
Chloropsis cyanopogon	G	5·2	2·0	2·0	4·3	1·5	4·0	1·0	3·0	3·2	5·0	4·3	2·0	143	3·5
Chloropsis sonnerati	G	1·5	1·5	2·0	1·7	3·2	1·0	1·7	1·7	5·5	2·0	3·5	1·0	59	2·0
No equivalent	K														
Irena puella	G	6·1	5·7	5·8	2·7	3·1	4·8	6·2	2·0	2·0	8·8	5·0	7·2	274	4·8
,, ,,	K	16·7	10·5	88·7	30·0	19·3	14·7	15·0	34·3	14·3	4·0	46·5	33·5	887	27·3
Gerygone fusca	G	1·6	2·0	2·0	2·0	2·4	2·4	1·5	1·5	3·1	2·1	2·5	3·2	129	2·0
No equivalent	K														
Aegithina viridissima	G	7·1	7·6	6·7	4·7	8·6	7·1	11·0	5·0	8·0	6·8	9·2	6·5	673	7·2
No equivalent	K														

TABLE 2-(7)

Species	Place	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total	Ave.
Orthotomus atrogularis	G	3·3	1·7	3·0	2·3	2·5	3·2	1·0	1·9	3·3	3·6	1·2	3·0	167	2·4
,, ,,	K			·7	3·0	1·3	1·3	2·0			·7	·5		28	1·3
Phylloscopus borealis	G	9·7	3·3	3·5							4·0	9·0	13·0	160	7·6
Phylloscopus spp.	K		·5	3·3	2·0						·5	4·0		26	2·0
Culicicapa ceylonensis	G	4·5	2·5	1·8	2·1	3·7	2·2	4·8	4·2	3·1	2·5	3·0	4·0	223	3·3
,, ,,	K	3·7									1·0	2·5	2·5	23	2·4
Arachnothera longirostris	G	10·8	10·0	7·0	8·4	9·0	9·1	8·7	12·0	7·4	5·4	6·0	10·3	710	8·4
,, ,,	K		·5	·3	1·7	3·0		·3		·3			1·0	20	1·0
Arachnothera chrysogenys	G	4·0	3·7	5·2	3·7	5·6	2·8	3·2	3·1	1·3	2·2	1·2	1·0	198	3·3
No equivalent	K														
Gracula religiosa	S*	4·0	1·2	2·1	1·8	1·4			1·0		1·5	1·0		89	2·0
,, ,,	K	102·3	16·0	9·0	7·0	11·0	12·0	20·0	44·0	6·3	9·0	73·5	40·0	908	29·2
Zosterops palpebrosa	G	8·0			12·5	12·0	6·0		3·0					57	8·1
,, ,,	K	5·3	10·0			1·7	8·0	12·0	60·3	38·7	2·0	2·5	5·0	427	14·5
Lonchura striata	G	6·6	10·5	35·0	6·2	2·3	6·5	2·5	7·4	6·6	9·2	6·0	3·0	451	10·2
,, ,,	K	·7	2·0	·7										8	1·1

* = Subang, a nearby secondary forest lower than Mile 13. Listed here for comparison. Not common at Gombak.

species apparently fill the same niche in each habitat they are compared. This table indicates seasonality as well. The figures given are the average birds tallied per observation without consideration of time involved or distance covered. Some species occurred in both forests. Some niches appeared to be occupied by more than one species in one forest and only one in the other. Some niches appeared to be occupied by one or several species in one forest and to be vacant in the other.

In any concept of niche the observer is at a handicap because of his inability to discern the parameters which delineate the niche from the standpoint of the organism occupying it. Inhibiting factors obvious to the organism may escape the observer. In these two forests the presence or absence of related species may be a function of the inability of the forest to provide what is needed to the birds even though the situation appears similar to the observer.

In both forests there were several conditions related to niche. These appeared to be: 1. Niche present in both and occupied by a species capable of increasing to an abundance (abundance is here interpreted to be in numbers so that 100 or more could be tallied). 2. Niche present and occupied only sparsely by a low level population. 3. Niche present but species capable of occupying it were absent. 4. Niche absent. We are still in the position of setting up such categories arbitrarily without reference to the organisms present or knowledge of their critical needs.

The less abundant species and their counterparts are listed in Table 3. Many of the differences evident here appear to be related to thermal conditions, for some species found at Khao Yai at 1000 to 2000 ft. (*c.* 500 m) are found in Malaya at 4000 to 6000 ft. (*c.* 1500 m).

Bird waves

'Wave' action of the birds was evident in both forests, however it appeared to be much more prevalent among the birds at Gombak than at Khao Yai. The birds of Khao Yai were more independent in their food gathering. Both forests had an abundance of insects, but at Khao Yai there was a year-round supply of fruit in greater quantities than was noted at Gombak. Frugivorous birds go to the feeding trees in flocks and mingle with other species present, but there is not the flock organization evident among the species as in a feeding flock of insectivores. A comparison of the flock dynamics is given in Table 4. Size of flock, number of species involved, etc. was similar for the two areas.

Aanlyses of feeding flocks have been reported by many observers including Moynihan (1962, Panama), McClure (1967, Malaya), Diamond & Terborgh (1967, Peru; 1970, New Guinea), Cody (1971, California) and in each paper the factors reported differ. The flocks discussed have varied from single species granivorous feeders through

TABLE 3

A COMPARATIVE LIST OF THOSE SPECIES WHICH DID NOT DEVELOP NUMERICAL ABUNDANCE, FILLED THE NICHES SPARSELY, OR CONVERSELY, THE HABITATS DID NOT PERMIT GREATER POPULATIONS ; OR THE NICHE WAS UNOCCUPIED

GOMBAK	KHAO YAI	GOMBAK	KHAO YAI
Aviceda leuphotes	*A. leuphotes*	*Cymbirhynchus macrorhynchus*	
	Gallus gallus		*Psarisomus dalhousiae*
Rollus roulroul		*Coracina fimbriata*	(*C. melaschista*
Chalcophaps indica	*C. indica*		(*C. polioptera*
Phaenicophaeus diardi	*P. tristis*	*Tephrodornis pondiceriana*	*T. pondiceriana*
P. chlorophus		*Pericrocotus divaricatus*	*P. divaricatus*
P. curvirostris			*Dicrurus leucophaeus*
P. javanicus			*D. remifer*
P. sumatranus		*Platysmurus leucopterus*	
Cuculus micropterus			*Cissa chinensis*
Surniculus lugubris	*S. lugubris*	*Melanochlora sultanea*	*M. sultanea*
	Carpococcyx renauldi	*Sitta frontalis*	*S. frontalis*
Batrachostoma stellatus			*Garrulax monilegerus*
Harpactes duvaucelii	(*H. erythrocephalus*		*Garrulax chinensis*
	(*H. oreskios*	*Macronus ptilosus*	
Lacedo pulchella	*L. pulchella*	*Criniger finschii*	
Ceyx rufidorsus		*Pycnonotus melanoleucos*	
Ceyx erithacus		*Pycnonotus squamatus*	
Nyctyornis amictus	*N. athertoni*	*Copsychus malabaricus*	*C. malabaricus*
Eurystomus orientalis	*E. orientalis*	*Enicurus ruficapillus*	(*E. leschenaulti*
Megalaima henrici			(*E. schistaceus*
Hemicircus concretus	*H. canente*	*Culicicapa ceylonensis*	*C. ceylonensis*
Meiglyptes tristis)	*M. jugularis*	*Hypothymis azurea*	*H. azurea*
Meiglyptes tukki)		*Rhipidura perlata*	
	Picus flavinuchus	*Terpsiphone paradisi*	*T. paradisi*
Sasia abnormis		*Lanius cristatus*	*L. cristatus*
Calyptomena viridis			
Eurylaimus ochromalus	*Serilophus lunatus*		

TABLE 4

A COMPARISON OF THE FLOCK DYNAMICS OF BIRD WAVES AT GOMBAK AND KHAO YAI

		Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Total or Ave.
Total flocks	G	36	7	10	21	74
	K	3	6	8	14	31
Total birds in flocks	G	1626	270	265	822	2983
	K	56	177	367	476	1076
Ave. no. species per flock	G	9	7	5	8·5	7·6
	K	10	9	9·7	7·2	9·0
Ave. no. birds per species per flock	G	2·4	3·1	2·1	2·9	2·7
	K	1·9	3·4	4·5	4·8	3·6
Ave. no. birds per flock	G	38	30	21	41	34
	K	19	30	46	34	32

many species of insectivores to many species of frugivorous forms using one tree. Each author has given his own interpretation to his observations.

The primary difference between the flocks of insectivores and those assembling in a fruiting tree is that the insectivore ' waves ' move through the forest (generally in a predictable pattern or territory) and the fruit eaters go to a specific tree. Many of the travelling waves contain fruit eaters which have joined them for varying periods or distances, such as the bulbuls or the barbets. If every species that is seen with such flocks is listed there will be many that occur only once in a series of observations. These may or may not be accidentally with the group. If they are seen on two occasions then the relationship may be more than casual. There were 68 species at Gombak and 43 at Khao Yai that were noted in association with feeding flocks two or more times.

McClure (1967) gives tables attempting to relate the species within these feeding flocks, based upon the numbers of times the birds were seen together. Table 5 duplicates this for the eleven species commonly found in waves at Mile 13 Gombak. In this table the figures are given as percentages of the total birds tallied. For example 75% of the 252 Yellowheaded Green Leafbirds (*Chloropsis cochinchinensis*) were seen in company with 83% of the 242 Minivets (*Pericrocotus flammeus* and *P. igneus*). With a less numerous form, 34% of the leafbirds were associated with 85% of the 27 Chestnutbreasted Malkoha (*P. curvirostris*). These data can be interpreted to indicate interspecific affinities, or simply the physical impossibility for 75 or 85% of the leafbirds to be in the flocks with the malkoha when there was only one tenth as many malkohas present.

TABLE 5.—THE NUMERICAL RELATIONSHIPS AMONG THE BIRDS COMMONLY FOUND IN FEEDING FLOCKS AT GOMBAK MILE 13

Species	1	2	3	4	5	6	7	8	9	10	11
1. *Chloropsis cochinchinensis*	**252**	75	46	43	44	46	36	28	23	34	24
2. *Pericrocotus flammeus* and *igneus*	83	**242**	51	39	46	49	38	23	26	35	18
3. *Alcippe poioicephala*	84	75	**215**	43	76	59	46	39	40	27	15
4. *Dicrurus paradiseus*	74	69	46	**58**	52	41	31	21	15	24	31
5. *Oriolus xanthonotus*	73	73	67	58	**48**	46	29	33	33	25	19
6. *Phylloscopus borealis*	82	72	52	41	43	**141**	43	29	22	35	16
7. *Terpsiphone paradisi*	85	76	61	30	42	54	**33**	33	24	33	30
8. *Irena puella*	78	80	35	28	65	30	17	**46**	17	41	33
9. *Hemipus picatus*	73	56	56	29	47	47	41	32	**34**	20	15
10. *Phoenicophaeus curvirostris*	85	85	37	52	48	48	37	41	33	**27**	18
11. *Aegithina viridissima*	69	74	48	55	28	45	50	17	19	14	**42**

TABLE 6.—THE NUMERICAL RELATIONSHIPS AMONG THE BIRDS COMMONLY FOUND IN FEEDING FLOCKS AT KHAO YAI

Species	1	2	3	4	5	6	7	8	9	10	11	12
1. *Hemipus picatus*	**60**	50	55	32	55	52	35	52	35	29	32	12
2. *Yuhina zantholeuca*	55	**69**	61	69	50	69	51	68	35	32	23	26
3. *Hypsipetes propinquus*	46	54	**52**	56	29	65	71	35	44	25	42	13
4. *Macronus gularis*	29	50	58	**38**	8	45	60	24	21	50	47	29
5. *Irena puella*	65	46	46	5	**54**	42	35	63	37	4	11	7
6. *Chloropsis cochinchinensis*	51	65	80	61	43	**51**	57	61	57	21	27	12
7. *Pycnonotus melanicterus*	28	81	54	42	49	47	**57**	70	54	26	26	3
8. *Pericrocotus flammeus*	73	81	52	31	77	67	64	**48**	50	8	12	0
9. *Zosterops palpebrosa*	51	51	68	32	60	77	64	65	**124**	18	28	6
10. *Culicicapa ceylonensis*	68	53	36	63	21	31	26	10	37	**19**	16	47
11. *Criniger pallidus*	65	55	90	59	34	69	48	34	41	21	**29**	7
12. *Hypothymis azurea*	50	87	50	67	33	25	12	**0**	12	87	12	**8**

Read Tables 5 and 6 horizontally : i.e. 84% of the *A. poioicephala* (Line 3, Column 1) were seen in association with 46% of the *C. cochinchinensis* (Line 1, Column 3). Bold faced numbers are the total birds tallied and the remainder are percentages of these figures.

Arranging the twelve common participants found in waves in Khao Yai in the same way (Table 6), the same relationships appear to be present.

Four species were common to bird waves in both forests, Yellow-headed Green Leafbird *Chloropsis cochinchinensis*, Barwinged Flycatcher-Shrike *Hemipus picatus*, Fairy Bluebird *Irena puella* and Scarlet Minivet *Pericrocotus flammeus*. In the Gombak 75% of the leafbirds were with 83% of the minivets. In Khao Yai 61% of the leafbirds were with 67% of the minivets, the same relationship. The temptation is to ascribe interspecific affinities or relationships to these observations. A review of both tables simply makes it evident that birds get together to find food. At Khao Yai the numerical abundance of species was in the same order, i.e. 60 *Hemipus picatus* and 51 *C. cochinchinensis* with 51% of the leafbirds in association with 52% of the flycatcher-shrikes. In the Gombak they were 252 leafbirds to 34 flycatcher-shrikes and a ratio of 23% of the leafbirds to 73% of the flycatcher-shrikes. A purely spatial and population density relationship in both cases. Species with similar food habits get together to hunt. To go further in interpretation is treading on shaky ground.

Summary

A comparison of the avifauna of the moist dipterocarp tropical rain forest at its northern edge in Thailand and in the centre of its range in Malaya reveals that there is a large species overlap between the two areas, that the population density in the northern edge of the forest was greater than in that under study in Malaysia, that both of these populations may be the result of edaphic conditions brought on by man disturbance. Niche occupancy in both forests was not the same, there being vacancies in both which were occupied in the other. The insectivores in both environments gathered into feeding flocks that moved through the forest each day. The species composition of these flocks depended upon those species available and lacked the complex flock organization reported from the neotropical forest.

References

Cody, M. L. (1971) : Finch flocks in the Mohave Desert. *Theoretical Population Biology* **2** : 142-58.

Diamond, J. M. & Terborgh, J. W. (1967) : Observations on bird distribution and feeding assemblages along the Rio Callaria, Department of Loreto, Peru. *Wilson Bull.* **79** : 273-82.

Hutchinson, G. E. (1957) : Concluding remarks. *Cold Spring Harbor Symp. Quant. Biol.* **22** : 415-27.

Karr, James R. (1971) : Structure of Avian communities in selected Panama and Illinois Habitats. *Ecol. Mong.* **41** : 207-33, No. 3.

McClure, H. Elliott (1965) : Com-

parison of the periods of residency of some migrant birds common to Japan and Malaya. *Misc. Reprints, Yamashina Institute of Ornithology and Zool.* **4**: 149-62.

——— (1966): Flowering, fruiting and animals in the canopy of a tropical rain forest. *Malayan Forester* **XXIX**: 182-203, No. 3.

——— (1967): The composition of mixed species flocks in lowland and submontane forests of Malaya. *Wilson Bull.* **79**: 131-54.

MOYNIHAN, M. (1962): The organization and probable evolution of some mixed species flocks of neotropical birds. *Smithsonian Misc. Collections* **143**, No. 7, 140 pp.

SMITINAND, TEM. (1968): Vegetation of Khao Yai National Park. *Nat'l Hist. Bull. Siam Soc.* **22**: 289-305.

TERBORGH, J. & DIAMOND, J. M. (1970): Niche overlap in feeding assemblages of New Guinea birds. *Wilson Bull.* **82**: 29-52.

UDVARDY, MIKLOS D. F. (1969): Dynamic Zoogeography. Van Nostrand Reinhold Co., New York, p. 149.

WYATT-SMITH, J. (1952): Malayan Forest Types. *Malayan Nat. Jr.* **7**: 45-55.